## REMARKS

In response to the Office action identified above, please accept the following remarks.

**Examiner:**

1. Claims 11-29 are objected to as they are numbered incorrectly. Claims 11-20 are all numbered as 1 and therefore, claims 21-29 are also incorrectly numbered. Correction is required.

**Response:**

Claims 11-29 are renumbered to overcome this objection. No new matter is introduced. Reconsideration of claims 11-29 is hereby requested.

**Examiner:**

3. Claims 1-29 are rejected under 35 U.S.C. 102(b) as being anticipated by US# 5,879,844 to Yamamoto et al.

Yamamoto teaches an optical proximity correction method. Yamamoto teaches making first correction on design data for a first area of a mask pattern using a prepared correction table containing correction values corresponding to a pattern and surrounding layout and making a second correction on the design data, for the other area of the mask pattern than the first area using correction amount calculated on the basis of simulation of an exposure process for a mask (col. 9, line 5-15). For example,

simulation-based correction is made on a gate layer in a memory while rule-based correction is made on a gate layer in the other area than the memory on the basis of rules for active gate width only (Abstract, col. 9, lines 25-35). Yamamoto teaches dividing a mask pattern to be corrected includes in the design pattern into areas of proper size; setting an optical proximity effect calculation area by selecting one of the areas and adding buffer areas to the periphery of the selected area; making optical proximity correction on the optical proximity effect calculation area on the basis of results of calculation by a simulator that models part or the whole of a lithography process or previously prepared correction rules; fetching a result of the correction on the selected area in the optical proximity effect calculation area after the termination of the correction of the optical proximity effect calculation area and acquires the result of the correction as the result of correction of the selected area in the mask pattern to be corrected; and when the buffer areas include area in which a pattern has corrected, setting the corrected pattern into the buffer areas (col. 12, lines 5-20). For areas which do not overlap, a group of uncorrected patterns is set as an initial input pattern group in the correction processing. For areas which do overlap, a group of correction completed patterns is set as an initial input pattern group. Thereby, correction calculation can be initiated with a pattern close to a correction solution as an initial input patter (col. 12, lines 33-35). Table 3 shows correction

values calculated for a given exposure and mask condition (col. 15, lines 45-67). Yamamoto teaches correcting the layout shown in Figure 16 (col. 16, lines 1-5). Figure 16 is a layout with different densities. The layout has semi-dense and isolated patterns.

**Response:**

First, claim 6 is merged into claim 1 to introduce the limitation of classifying the line patterns according to the line width deviation data comprising deviation data of an after-etch-inspection critical dimension measured from the transferred line patterns onto a wafer. The introduced limitation in the amended claim 1 is also referred to paragraph [0027] of the specification of the present application. No new matter is introduced.

Second, the Applicants intend to point out the difference between the amended claim 1 of the present application and Yamamoto's optical proximity correction method. The amended claim 1 of the present application is repeated below:

Claim 1 (Currently amended): A method of correcting a mask layout, the mask layout comprising a plurality of line patterns, the method comprising:

providing line width deviation data of transferred line patterns, ***the line width deviation comprising a deviation of an after-etch-inspection critical dimension of the transferred line patterns onto a wafer;***

executing an inspection program to classify the line patterns of the mask layout into at least a first-type line pattern and a second-type line pattern ***according to the line width deviation data of the transferred line patterns;*** and

making a line width correction of a first constant value on the first-type line pattern and making a line width correction of a second constant value on the second-type line pattern.

As disclosed in the amended claim 1, the line patterns of the mask layout are classified according to the line width deviation data of the "transferred" line patterns. More specifically, the line patterns of the mask layout are classified according to the deviation of the after-etch-inspection critical dimension (AEI CD) measured from the etched line patterns on the wafer. Following that, the line width correction with a constant value is made in the classified line patterns of the mask layout, so as to overcome the micro-loading effect in the etching process and improve the surface uniformity of the wafer.

Yamamoto teaches to calculate correction values under specific exposure and mask conditions, thereby obtaining the specific correction value corresponding to the specific distance between two line patterns (TABLE 3, and col. 15, lines 45). However, Yamamoto never mentions to classify the line patterns of the mask layout according to the line width deviation data of the "transferred (etched)"

line patterns, as is disclosed in the amended claim 1 of the present application. Yamamoto teaches to correct the line width of the line patterns shown in FIG. 16 according to the distance between edge of interest and adjacent pattern (FIG. 16, and col. 16, lines 4-11). Obviously, Yamamoto corrects the line patterns of the mask layout according to the line densities of the mask layout itself, he never teaches or implies to utilize the deviation data of the transferred line patterns to classify or correct the mask layout.

From the above discussion, the Applicants believe that the amended claim 1 of the present application is absolutely different from Yamamoto's disclosure. Reconsideration of the amended claim 1 is politely requested.

The other independent claim 11 is amended to introduce the similar limitation as is introduced in the amended claim 1. Reconsideration of the amended claim 11 is therefore requested.

As claims 2-5, and 7-10 are dependent upon the amended claim 1, they should be allowed if the amended claim 1 is allowed. Claims 12, 14-16, and 18-20 are dependent upon the amended claim 11 and should be allowed if the amended claim 11 is allowed. Reconsideration of claims 2-5, 7-10, 12, 14-16, and 18-20 is therefore politely requested.

Claims 6, 13, 17, and 21-29 are canceled and

thereby no longer in need of consideration.

**Examiner:**

4. Claims 1-29 are rejected under 35 U.S.C. 102(b) as being anticipated by US# 5,916,716 to Butsch et al.

Butsch teaches that across ship line width variations and other repetitive deviations from the design pattern desired are compensated for by examining each of the regions of a patterned substrate, determining the amounting of deviation for each region, and using the determined regional deviation as a local bias when patterning subsequent substrates (Abstract). Thus, the E-beam lithography tool will utilize both global and local biases in order to produce new patterns. Butsch teaches that horizontal and vertical deviations from the design pattern are determined for a plurality of regions on the substrate, where the regions can constitute different fields, sub-fields, frames or strips. The deviations are used as a local bias such that each region of substrate being patterned has both global and local biases and the resulting substrate lacks the repetitive pattern deviations which are produced when local biasing is not used (col. 1, lines 55-67). The tool can be provided for writing wider or narrower lines (col. 2, lines 5-10). Butsch teaches that each field is built up from a plurality of sub-fields. Patterns are created in the fields from several discrete patterns in the sub-fields. The patterns can be defined by rectangles or blocks (col. 2, lines

60-65). The difference in image size between the design shapes and the patterned images which are ultimately produced is referred to as "bias" or "etch" (col. 3, lines 20-23). Global bias helps compensate for process variations that result from choice of resist, choice of developer, plating material, type of etching, periodic column charging, variations in the speed of movement of the wafer table, or other process parameters (col. 3, lines 35-45). Butsch also teaches that tool commands must be revised for each region to specify larger or smaller line width dimensions. Therefore, Butsch teaches different densities (col. 5, lines 20-25). Butsch teaches after performing the process steps, the line width variation for each of a plurality of regions is known. A look up table will then be constructed which includes for each region the line width variation, the current density required to achieve the line width variation, and the optimum focus for the current density (col. 6, lines 18-25). Butsch also teaches making masks with corrections derived from either the mask or the final wafer (col. 6, lines 30-34).

**Response:**

Claim 1 is amended to overcome this rejection. The amended claim 1 introduces the limitation of classifying the line patterns according to the line width deviation data comprising deviation data of an after-etch-inspection critical dimension measured from the transferred line patterns. Following that, the line width correction with a

constant value is made in the classified line patterns of the mask layout, so as to overcome the micro-loading effect in the etching process and improve the surface uniformity of the wafer.

As shown in FIG.2 of Butsch's disclosure, several exposures are performed to form a desired pattern on a substrate (step 20), a local bias (mean line width "x/y", "x", "y") is determined for each field or strip from step 30, and the local bias would be used in step 40 to adjust the tool commands of the E-beam lithography system on a field-by-field or strip-by-strip or region-by region bias (col. 4, lines 29-34). Butsch determines the local bias of each "field" or "strip". In other words, Butsch divides the patterns of the mask layout into fields or strips and determines the local bias (the mean line width) for the patterns divided in each field or strip. However, Butsch never discloses the concept of classifying the patterns of the mask layout according to the line width deviation data comprising deviation data of an after-etch-inspection critical dimension measured from the "transferred" line patterns, as is disclosed in the amended claim 1 of the present application. Therefore, the Applicants believe that the amended claim 1 of the present application is absolutely different from Butsch's disclosure. Reconsideration of the amended claim 1 is politely requested.

The other independent claim 11 is amended to introduce the similar limitation as is introduced

in the amended claim 1. Reconsideration of the amended claim 11 is therefore requested.

As claims 2-5, and 7-10 are dependent upon the amended claim 1, they should be allowed if the amended claim 1 is allowed. Claims 12, 14-16, and 18-20 are dependent upon the amended claim 11 and should be allowed if the amended claim 11 is allowed. Reconsideration of claims 2-5, 7-10, 12, 14-16, and 18-20 is therefore politely requested.

Claims 6, 13, 17, and 21-29 are canceled and thereby no longer in need of consideration.

**Examiner:**

5. Claims 1-29 are rejected under 35 U.S.C. 102(b) as being anticipated by US# 6,120,953 to Lin.

Lin teaches an optical proximity correction method. When the critical dimension is reduced to reach a first reference value or below, a serif/hammerhead is added onto the main pattern. When the critical dimension is further reduced to a second reference value or below, an assist feature is added onto the main pattern. The corrected pattern is then transferred to a layer on wafer with an improved fidelity (Abstract). Using the critical dimension (CD) of an original main pattern as a determinant of whether an optical proximity correction is performed on the original main pattern, neither an empirical result nor a relationship between two adjacent layers is required. Therefore, data

handling is simplified while fidelity of a transferred pattern is retained. In the invention, an original pattern to be transferred is provided. The critical dimension of the original pattern is obtained. When the critical dimension is less than or equal to 2.5 times of a wavelength of an exposure light source, serifs are added on each corner of the original pattern, or a hammerhead is added onto each trunk of the pattern. If the critical dimension is less than or equal to the wavelength, an assist feature is added into the original pattern. The original pattern is thus corrected for forwarding an exposure step of a photolithography process. In addition, by correcting the original in a sequence of adding the serifs and hammerhead in front of adding the assist feature, an overlap in the corrected pattern or an overly reduced distance is avoided (col. 2, lines 20-40). The addition of serifs or the hammerhead improves fidelity of the pattern, while the addition of the assist feature increases a contrast of the pattern to result in a higher resolution. In Figure 3B, Lin teaches that a distance between two neighboring patterns is too small and that in some occasions, the patterns may even overlap with each other to cause connections (col. 3, lines 37-46). Therefore, Lin teaches the different densities.

**Response:**

Claim 1 is amended to overcome this rejection. The amended claim 1 introduces the limitation of classifying the line patterns according to the line



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width deviation data comprising deviation data of an after-etch-inspection critical dimension measured from the transferred line patterns. Following that, the line width correction with a constant value is made in the classified line patterns of the mask layout, so as to overcome the micro-loading effect in the etching process and improve the surface uniformity of the wafer.

Lin clearly teaches to use the critical dimension of an "original main pattern" as a determinant of whether an optical proximity correction is performed on the original main pattern, neither an empirical result nor a relationship between two adjacent layers is required (col. 2, lines 19-26). It is very obvious that Lin never teaches or implies to utilize the "deviation data" of the "transferred" line patterns to classify or correct the mask layout, as is disclosed in the amended claim 1 of the present application. Therefore, the Applicants believe that the amended claim 1 of the present application is absolutely different from Lin's disclosure. Reconsideration of the amended claim 1 is politely requested.

The other independent claim 11 is amended to introduce the similar limitation as is introduced in the amended claim 1. Reconsideration of the amended claim 11 is therefore requested.

As claims 2-5, and 7-10 are dependent upon the amended claim 1, they should be allowed if the amended

claim 1 is allowed. Claims 12, 14-16, and 18-20 are dependent upon the amended claim 11 and should be allowed if the amended claim 11 is allowed. Reconsideration of claims 2-5, 7-10, 12, 14-16, and 18-20 is therefore politely requested.

Claims 6, 13, 17, and 21-29 are canceled and thereby no longer in need of consideration.

**Examiner:**

6. Claims 1-29 are rejected under 35 U.S.C. 102(e) as being anticipated by US# 6,475,684 to Ki.

Ki teaches that a variation in line width caused by a loading effect generated due to the non-uniformity of a loading density is reduced by a method of performing correction exposure using a dose corresponding to the loading effect due to a desired pattern which is calculated from a relationship represented as the convolution of a Gaussian distribution and a loading density (Abstract). Ki teaches macro and micro effects. Ki also teaches that the line width of a portion of the opaque layer having a high loading density is larger than that of a portion of the opaque layer having a low loading density (col. 1, lines 15-35). The line width variation due to the loading effect caused upon dry etching can be largely corrected by adjustment of an etching condition or by exposure with an additional compensation dose (col. 1, lines 45-60). Ki teaches the method of correcting a variation in line width due to a loading effect generated when



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the material layer on a photomask substrate is dry-etched to have a desired pattern, in which, first, a loading effect range is obtained by dividing the substrate into meshes, and supposing the distribution of a loading effect frequency representing the degree of a loading effect at an arbitrary mesh on the substrate from each of the meshes to be a Gaussian distribution expresses in an equation. Next, the loading density of the desired pattern, which is defined as a ratio of the area to be etched to the entire area in each mesh, is calculated. The loading effect at each of the meshes on the substrate can be calculated by convoluting the loading density of the desired pattern and the loading effect frequency obtained from the loading effect range. An electron beam resist is correction-exposed according to the loading effect calculated at each of the meshes on the substrate. In this way, a variation in line width is corrected (col. 2, line 5-30). The step of obtaining a loading effect range can include the step of forming test patterns by exposing, developing and etching a photomask substrate, and measuring the line width of the test pattern, and the step of calculating the loading effect expresses as the above-described equation an arbitrary loading effect range value, comparing the loading effects with the line widths of the test pattern at the meshes, and selecting a loading effect range in which the deviation between them is minimum (col. 2, lines 40-50). Figure 1 shows the sequence of correcting line width variation generated due to loading effect. Ki teaches a

photomask in Figure 4B. Since the basic patterns occupy very small areas on the photomask substrate, the right side of the photomask substrate has a very high loading density and the left portion of the substrate has a very low loading density (col. 5, lines 50-55). A large loading effect is shown at the center of the substrate having many peripheral patterns while a small loading effect is shown at the edge of the substrate having a small number of peripheral patterns (col. 6, lines 30-40).

**Response:**

Claim 1 is amended to overcome this rejection. The amended claim 1 introduces the limitation of classifying the line patterns according to the line width deviation data comprising deviation data of an after-etch-inspection critical dimension measured from the transferred line patterns. Following that, the line width correction with a constant value is made in the classified line patterns of the mask layout, so as to overcome the micro-loading effect in the etching process and improve the surface uniformity of the wafer.

Ki teaches an exposing method for correcting a loading effect caused when a photomask substrate is dry-etched. As shown in FIG. 1 of Ki's disclosure, the photomask substrate is divided into meshes to calculate a loading effect range (step I), the loading effect at each mesh is then calculated using the obtained loading effect range and the loading density of a desired pattern (step II), and the

correction exposure is performed on each mesh using the calculated loading effect (step III). Ki teaches to divide the photomask substrate into meshes, however, he does not disclose the concept of classifying the patterns of the mask layout according to the "line width deviation data" of the "transferred (etched)" line patterns, as is disclosed in the amended claim 1 of present application. In addition, Ki teaches to correct the "exposure" condition of each mesh using the calculated loading effect, however, he does not disclose the concept of making a "line width correction with a constant value" in the classified patterns of the mask layout, as is disclosed in the amended claim 1 of the present application. Therefore, the Applicants believe that the amended claim 1 of the present application is absolutely different from Ki's disclosure. Reconsideration of the amended claim 1 is politely requested.

The other independent claim 11 is amended to introduce the similar limitation as is introduced in the amended claim 1. Reconsideration of the amended claim 11 is therefore requested.

As claims 2-5, and 7-10 are dependent upon the amended claim 1, they should be allowed if the amended claim 1 is allowed. Claims 12, 14-16, and 18-20 are dependent upon the amended claim 11 and should be allowed if the amended claim 11 is allowed. Reconsideration of claims 2-5, 7-10, 12, 14-16, and 18-20 is therefore politely requested.

Claims 6, 13, 17, and 21-29 are canceled and thereby no longer in need of consideration.

**Examiner:**

7. Claims 1-29 are rejected under 35 U.S.C. 102(e) as being anticipated by US# 6,586,146 to Chang et al.

Chang teaches a method of figuring an exposure energy. A first CD deviation is obtained from a layer before the exposing layer. From the first CD deviation, a first energy compensation is calculated. Whether the deviation of photoresist sensitivity of two sequential batches is less than 1% is checked. If the deviation of photoresist sensitivity of two sequential batches is less than 1%, a sum of the required exposure energy and the first energy compensation is the exposure energy applied to the exposing layer. Otherwise, a second CD deviation is commutated according to the deviation of photoresist sensitivity of two sequential batches. A second energy compensation is then obtained from the second CD deviation, and a sum of the required exposure energy and the first/second energy compensation is the exposure energy applied to the exposing layer (Abstract). The first energy compensation is calculated using the CD deviation. That is, the CD deviation is derived from the thin film thickness of the layer prior to the exposing layer and a critical dimension specification target (col. 2, lines 55-61). In Figure 5, the linear regression formula of the



 

critical dimension and the exposure energy is used to obtain the first energy compensation (col. 3, lines 24-28). In the method of calculating the second CD deviation, the linear correlation between the photoresist sensitivity and the critical dimension is used to obtain the second CD deviation (col. 3, lines 55-60). A second energy compensation is obtained from the second CD deviation. The second CD deviation is substituted into the linear correlation formula that was used to obtain the first energy compensation (col. 4, lines 10-15).

**Response:**

Claim 1 is amended to overcome this rejection. The amended claim 1 introduces the limitation of classifying the line patterns according to the line width deviation data comprising deviation data of an after-etch-inspection critical dimension measured from the transferred line patterns. Following that, the line width correction with a constant value is made in the classified line patterns of the mask layout, so as to overcome the micro-loading effect in the etching process and improve the surface uniformity of the wafer.

Chang et al. teaches a method of figuring an exposure energy. However, Chang et al. never discloses the concepts of classifying the patterns of the mask layout according to the line width deviation data of the transferred (etched) line patterns, and making a line width correction with a constant value in the classified patterns of the

mask layout, as is disclosed in the amended claim 1 of the present application. Therefore, the Applicants believe that the amended claim 1 of the present application is absolutely different from Chang et al.'s disclosure. Reconsideration of the amended claim 1 is politely requested.

The other independent claim 11 is amended to introduce the similar limitation as is introduced in the amended claim 1. Reconsideration of the amended claim 11 is therefore requested.

As claims 2-5, and 7-10 are dependent upon the amended claim 1, they should be allowed if the amended claim 1 is allowed. Claims 12, 14-16, and 18-20 are dependent upon the amended claim 11 and should be allowed if the amended claim 11 is allowed. Reconsideration of claims 2-5, 7-10, 12, 14-16, and 18-20 is therefore politely requested.

Claims 6, 13, 17, and 21-29 are canceled and thereby no longer in need of consideration.

Sincerely yours,

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